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OPPENHEIMER CAMERA
PRODUCTS, INC.; and MARTY
OPPENHEIMER

UNITED STATES DISTRICT COURT

CENTRAL DISTRICT OF CALIFORNIA

VOICE INTERNATIONAL, INC., a California corporation; DAVID GROBER, an individual, Plaintiffs, vs. OPPENHEIMER CINE RENTAL, LLC, a Washington corporation; OPPENHEIMER CAMERA PRODUCTS, INC., a Washington corporation; MARTY OPPENHEIMER, an individual; JORDAN KLEIN, SR., an individual; JORDAN KLEIN, JR., an individual; JOHN DANN, an individual; Mako Products, an unknown entity, Oceanic Production Equipment, Ltd., a Bahamian company; and DOES 1-10, inclusive, Defendants.	Case No. 2:15-cv-08830-JAK-KS Honorable John A. Kronstadt **DECLARATION OF THOMAS H. SMITH IN SUPPORT OF OPPENHEIMER DEFENDANTS' MOTION FOR SUMMARY JUDGMENT OF NON-INFRINGEMENT** Complaint Filed: November 12, 2015 Hearing Date: July 3, 2017 Time: 8:30 a.m. Place: Courtroom 10B First Street Courthouse 350 W. First St. Los Angeles, CA

1. I, Thomas H. Smith, am a competent adult and a citizen of the United States of America.
2. I have personal knowledge of the matters contained herein, and if called as a witness I could and would testify thereto under oath.
3. I own Fern Creek Electronics, Inc. ("FCE"), a Florida corporation. I am the only employee of FCE. FCE designs and builds equipment systems for customers.
4. I graduated from University of Tennessee in June, 1970, with a Degree of Bachelor of Science in Electrical Engineering (BSEE). Since 1970, I have worked for various corporations engaged in the design of inertially stabilized electro-optical sensor systems intended for defense applications. At those corporations I engaged in electronic design of subsystems of the defense systems. From that work I became familiar with the various sensor types used in those stabilized systems. Further, I became familiar with the system, mechanical, and electronic aspects of those defense systems. I gained familiarity with software design by taking courses at an Orlando junior college relating to writing software in "C".
5. I have extensive experience with stabilization systems. My experience spans over three decades, during which my work focused on stabilization systems. From 1970 to 1983 I worked for Martin Marietta Corp., Orlando, FL, where

I engaged in analog and digital design for airborne electro-optical equipment employing stabilized line-of-sight television cameras, for military applications. From 1983 to 1987 I worked for Parks-Jaggers Aerospace, Orlando, FL. as a Sr. Engineer and Electrical Engineering Task Leader. There I engaged in analog design for stabilization servo systems for two axis electro-optical systems employing stabilized line-of-sight television cameras for military applications. From 1987 to 1997 I worked at Westinghouse Electro-Optical Systems, Orlando, FL, as a Sr. Engineer and Engineering Manager. There I designed, debugged, and redesigned components of inertially stabilized television systems for military applications. From 1997 to 2000 I worked for Schwartz Electro-Optics Inc., Orlando, FL, as a contract engineer. There I provided services for engineering design, fabrication and test for electronic components of an inertial stabilization system for a large, two-axis gimbal for a military application. The stabilization system included two fiber-optic gyros as angular rate sensors and it used two inductosyns as angle position sensors. I also designed electronic power amplifiers to drive the large, direct-drive DC torque motors which were used in the gimbal as the means to provide stabilizing motions or torques. From 2000 to 2004 I worked for Imaging Sensors and Systems,

Orlando, FL, as a Contract Engineer. There I redesigned a circuit for a 2-axis stabilized line-of-sight airborne gimbal system.

6. From 2000 to present I have owned and operated Fern Creek Electronics Inc., Orlando, FL, (FCE) where I continue to work on stabilization systems, among other projects, including single-axis, stabilized camera mounts; a pan stabilizer; a tilt stabilizer, and other projects involving motor control.

7. I have published one article, in a magazine directed to amateur electronic and robotic enthusiasts. That article was titled "Power-Assisted Cart" by Thomas H. Smith. It appeared in the January, 2006, issue (Volume 4, Number 1) of "Servo Magazine" published by T &L Publications, Inc., of Corona, California.

8. I am being compensated for my time spent on this matter at my usual and customary rate. My compensation is not related to the outcome of this action and I have no financial interest in this case.

9. I testified as an expert in Grober v. Mako Products Inc. et al, Case No. 04-CV-8604.

10. Mako Products Inc. contracted FCE to design and implement electronics and software for the stabilization system, known as MakoHead. The project included conceptualization of electronic systems, as well as selection, configuration and installation of motors and sensors for MakoHead; creation

of circuit boards for power management, signal processing and for driving motors; and development of software for microprocessors used in the circuit boards. FCE outsourced some early software development to an individual experienced in writing software that controlled gimbaled electronic systems for the U.S. defense industry. FCE did not create the mechanical design for MakoHead. The FCE design and component selection process for MakoHead was based upon my accumulated knowledge of the implementations for the inertially stabilized systems with which I had worked previously.

11. I am thoroughly familiar with all aspects of MakoHead, including the mechanical, electronic, and software components that comprise MakoHead. I am thoroughly familiar with the construction, operation and performance of MakoHead. I am thoroughly familiar with the sensors, sensor signals, signal processing logic, and motor drivers for MakoHead.

12. Figures 1 through 4 attached hereto conceptually illustrate mechanical components of MakoHead. Figure 1 illustrates an assembled MakoHead. Figures 2 through 4 provide various perspective exploded views of a MakoHead. Figure 5 is a photograph of a MakoHead, consistent in all material respects with the illustrations of Figures 1 through 4. Figure 6 is a block diagram that conceptually illustrates all relevant electrical components

of MakoHead. Reference numerals associated with components in the Figures are used in the text below.

13. With reference to Figures 1 through 5, MakoHead includes a base plate 105 and a Mitchell stud 100. The Mitchell stud 100 mates with a Mitchell nut (not illustrated) to rigidly secure the base plate 105 to a support surface with a corresponding hole. The support surface is sandwiched between the base plate 105 and the nut. The support surface may be considered to be stationary or of fixed position relative to the vehicle upon which Mako Head is mounted.

14. A yoke 110 is rigidly attached to the base plate 105. The yoke 110 is a Y-shaped support structure with a neck extending from the base plate 105 and a pair of spaced apart arms extending from the neck. The two ends of the spaced-apart arms include a pair of parallel aligned gimbal mounts for an outer gimbal 135. The outer gimbal 135, which is mounted between the arms of the yoke 110, pivots about an axis 125 extending through the outer gimbal mounts. This axis 125 defines the axis of rotation (i.e., the outer axis 125) about which the outer gimbal 135 rotates.

15. The outer gimbal 135 includes a pair of axially-aligned, spaced-apart gimbal mounts. An inner gimbal 140 is mounted to the outer gimbal 135, between the pair of spaced apart gimbal mounts of the outer gimbal 135. The inner

gimbal 140 pivots about an axis 130 extending through the gimbal mounts of the outer gimbal 135. The axis of rotation for the inner gimbal 140, i.e., axis 130, is perpendicular to the axis of rotation for the outer gimbal 135, i.e., axis 125.

16. Axis 125 is referred to as the outer axis. Axis 130 is referred to as the inner axis. Both axes 125, 130 are spaced apart from the base plate 105. During use of MakoHead, the inner axis 130 constantly moves relative to the base plate 105. This movement of the inner axis relative to the base plate 105 is due to rotation of the outer gimbal 135 which in turn is due to rotation of the rotor of the outer axis motor 230o. Motion of the inner axis 130 is not the same as motion of the base plate 105.

17. MakoHead includes two stepper motors, each coupled to a gear drive and each configured to rotate one of the gimbals about one of the axes of rotation. The outer motor housing 120 contains a stepper motor (i.e., the outer axis motor 230o) that rotates the outer gimbal 135 about the outer axis 125. The outer motor housing 120 and the body of the contained outer axis motor 230o are rigidly coupled to the yoke 110. Output from a shaft of the outer axis motor 230o powers a gear drive 124 (i.e., an outer axis geared speed reducer), which rotates (i.e., rotates relative to the yoke 110) the outer gimbal 135 about the outer axis 125.

18. The inner motor housing 115 contains a stepper motor (i.e., the inner axis motor 230i) that rotates the inner gimbal 140 about the inner axis 130. The inner motor housing 115 and the body of the contained inner axis motor 230i are rigidly coupled to the outer gimbal 135. Output from a shaft of the inner axis motor 230i powers a gear drive 119 (i.e., an inner axis geared speed reducer), which rotates (i.e., rotates relative to the outer gimbal 135) the inner gimbal 140 about the inner axis 130.

19. With reference to Figure 6, each motor housing 115 (inner), 120 (outer) contains a stepper motor 230i, 230o, three circuit boards 215i, 220i, 225i (inner) and 215o, 220o, 225o (outer) attached to the exterior body of each stepper motor 230i, 230o, only one single-axis sensor 210i, 210o, and transformer oil. The transformer oil serves as a coolant. Two of the three boards are coil driver power amplifiers 220i, 225i and 220o, 225o. Each stepper motor 230i, 230o contains two coils. A separate coil driver power amplifier serves each coil. The third board is a motor control board 215i, 215o. The motor control board 215i, 215o processes orientation and rate signals and produces control signal outputs which in turn control the power output from each coil driver power amplifier 220i, 225i and 220o, 225o.

20. The motor control board 215i, 215o within each each motor housing 115, 120 provides a separate control system for each of the two stepper motors

230i, 230o. The two control systems operate independently of each other. Either control system may be disabled and the other will continue to operate.

21. The one sensor contained in each motor housing 115, 120 is a single-axis angular rate sensor 210i, 210o. The sensor is attached to its respective motor control board (215i, 215o), which is attached to the exterior body of its respective stepper motor, with the input axis for the sensor aligned with the output shaft of the stepper motor. Each angular rate sensor measures angular rate only about one axis, i.e., the input axis for the sensor. The input axis for each sensor has a fixed mechanical orientation with respect to the body of the sensor. The body of the sensor has a fixed mechanical orientation with respect to the associated motor 230i, 230o and to the motor housing 115, 120. An electrical signal produced by each angular rate sensor provides a measurement of the angular rotation sensed by that rate sensor only about its input axis.

22. The outer axis angular rate sensor 210o, which is contained within the outer motor housing 120, is aligned with its input axis always parallel to the axis of rotation 125 of the outer gimbal structure 135 and parallel to the shaft of the outer axis motor 230o contained within the outer motor housing 120. The inner axis angular rate sensor 210i, which is contained within the inner motor housing 115, is aligned with its input axis always parallel to the axis

of rotation 130 of the inner gimbal structure 140 and parallel to the shaft of the inner axis motor 230i contained within the inner motor housing 115.

23. The electrical signal output from the angular rate sensor contained in each motor housing 115, 120, is supplied only to the motor control board within that housing. Thus, the angular rate sensor 210o within the outer motor housing 120 supplies signals only to the motor control board 215o within the outer motor housing 120. Likewise, the angular rate sensor 210i within the inner motor housing 115 supplies signals only to the motor control board 215i within the inner motor housing 115. Signals output from the angular rate sensor 210i within the inner motor housing 115 are not supplied to the motor control board 215o within the outer motor housing 120. Signals output from the angular rate sensor 210o within the outer motor housing 120 are not supplied to the motor control board 215i within the inner motor housing 115.

24. As each angular rate sensor is a single-axis sensor, it is incapable of measuring any motion, other than angular rate about a single axis, i.e., its input axis. Each angular rate sensor measures an angular velocity (in degrees per second or radians per second) only about its input axis. Each angular rate sensor cannot measure any motion except a rotational angular velocity about the input axis of the sensor. Each angular rate sensor cannot

measure motion about an axis that is orthogonal to the input axis of the angular rate sensor. The outer axis angular rate sensor 210o does not respond to rotation about the axis of rotation 130 of the inner gimbal structure 140. The inner axis angular rate sensor 210i does not respond to rotation about the axis of rotation 125 of the outer gimbal structure 135. The inner axis angular rate sensor 210i cannot measure motion (rotation) of the base plate 105 because the inner axis angular rate sensor 210i constantly moves with respect to the base plate 105.

25. A removable payload platform 155 is located at the nominal top of MakoHead. The payload platform 155 may comprise one or more plates, each having a hole with a diameter of approximately three and one-eighth inches for the passage of a Mitchell stud that extends from the bottom of the payload. A Mitchell nut secures the Mitchell stud of the payload to the payload platform 155. There are no sensors mounted to the payload platform 155.

26. An upper sensor enclosure 150 is attached to the top of the inner gimbal assembly 140. The upper sensor enclosure 150 contains circuit boards and several sensors, including a single-axis pan angular rate sensor and several accelerometers, each at a fixed position in the upper sensor enclosure 150. The input axis of the pan angular rate sensor is always perpendicular to the

axis of rotation 130 of the inner gimbal structure 140 and always parallel to pan axis 160, which extends normal to the top surface of the upper sensor enclosure 150. The pan angular rate sensor measures rotations only about the input axis of the pan rate sensor. The pan angle rate sensor is used in conjunction with the outer axis angle rate sensor 210o to partially control rotation of the outer axis stepper motor 215o. The pan angle rate sensor is not used for control of the inner axis stepper motor 215i. The pan angle rate sensor is fixed relative to the upper sensor enclosure 150 which is attached to the inner gimbal assembly 140, which rotates relative to the base plate 105. Thus the pan angle rate sensor moves relative to the base plate 105 and cannot measure motion (rotation) of the base plate 105 or of a moving object to which the base plate 105 is attached.

27. The sensors within the upper sensor enclosure 150 include one vertical accelerometer with an input axis that is parallel to the pan axis 160 and two accelerometers, which detect rotation about two mutually perpendicular axes that are perpendicular to the pan axis 160 and parallel to the top surface of the upper sensor enclosure 150. These two accelerometers operate as level sensors and measure angular position orientation of the upper sensor enclosure relative to a horizontal plane. Output signals from the sensors in the upper sensor enclosure 150 are provided to the circuit boards within the

upper sensor enclosure 150 for processing. Output signals from the circuit boards within the upper sensor enclosure 150 are provided to the motor control boards 215i, 215o within the inner and outer motor housings 115, 120. When the payload platform 155 is level the pan axis is vertical.

28. MakoHead also has a potentiometer that measures the angular orientation between the inner gimbal structure 140 and the outer gimbal structure 135. This potentiometer (the "inner gimbal angle pot.") has two principal mechanical parts: a body rigidly attached to the inner gimbal structure 140 and a rotating shaft rigidly attached to the outer gimbal structure 135. During use, both the inner gimbal 140 and outer gimbal 135 constantly move relative to the base plate 105. The potentiometer provides angle information in the form of an analog electronic signal, which is communicated to the circuit boards in the upper sensor enclosure 150. The angle measured by this potentiometer is the angle between the inner gimbal structure 140 and the outer gimbal structure 135.

29. Control of the inner axis motor 230i is accomplished based on a combination of electronic signals from the inner axis angular rate sensor 210i and from an inner axis level sensor via the output from circuit boards in the upper sensor enclosure 150. Control of the outer axis motor contained within the outer motor housing 120 is accomplished based on a combination of electronic

signals from the outer axis angular rate sensor 210o and signals from an outer axis level sensor, the pan axis rate sensor, and the gimbal angle potentiometer via an output signal from circuit boards in the upper sensor enclosure 150.

30. A power supply enclosure 145 is also attached to the nominal top of the inner gimbal assembly 140. An external battery supplies power to MakoHead. A battery voltage monitor, a power relay, a power switch and an LED indicator control the supply of electric power to components of MakoHead.

31. MakoHead does not determine motion of the base plate 105, or of a moving object on which the base plate 105 may be mounted, in two orthogonal, perpendicular, or transverse dimensions or directions. MakoHead does not have a sensor package for determining, in two transverse directions, motion of a moving object on which the stabilized platform is mounted. MakoHead does not have a sensor package fixed to the base (i.e., base plate 105) for determining motion of a vehicle on which the stabilized platform is mounted in two perpendicular directions.

32. MakoHead has only one single-axis motion sensor (i.e., outer axis angular rate sensor 210o) that is fixed relative to the base plate 105. The outer axis angular rate sensor 210o cannot measure motion in two dimensions. The

outer axis angular rate sensor 210o cannot provide sufficient information to stabilize the payload platform in at least two dimensions. The outer axis angular rate sensor 210o cannot collect information that is sufficient to stabilize the payload platform in at least two dimensions. Therefore, MakoHead does not stabilize the payload platform 155 in at least two dimensions based on information collected by a sensor package sensing motion of the moving object independent of motion of the payload platform. Likewise, MakoHead does not continuously stabilize the payload platform in at least two dimensions based on information collected by a sensor package fixed relative to the moving vehicle and sensing motion of the moving vehicle.

33. MakoHead's outer axis angular rate sensor 210o, which is contained within the outer motor housing 120, is aligned with its input axis always parallel to the axis of rotation 125 of the outer gimbal structure 135 and parallel to the shaft of the outer axis motor 230o contained within the outer motor housing 120. MakoHead's outer axis angular rate sensor 210o does not sense motion, except rotational motion about a single axis, i.e., its input axis. The outer axis angular rate sensor 210o senses only rotational motion and only about the outer axis 125. By way of example, linear (e.g., up-and-down or side-to-side or front-to-back) motion of the base plate 105 is not sensed by the outer

axis angular rate sensor 210o, because such motion does not include rotational motion about the outer axis 125. Rotation about an axis that is orthogonal to the outer axis 125 is not sensed by the outer axis angular rate sensor 210o. Rotation about an axis that is askew, but not orthogonal, to the outer axis 125 may include a component of motion that is sensed by the outer axis angular rate sensor 210o. Other components of such rotational motion about an askew axis cannot be, and are not, determined from the sensed component. Therefore, the rotation about an axis that is askew to the outer axis 125 cannot be determined by the single axis outer axis angular rate sensor 210o.

34. MakoHead's inner axis angular rate sensor 210i does not sense motion of the base plate 105 or any object to which the base plate 105 is attached. The inner axis angular rate sensor 210i senses only rotational motion about the inner axis 130. By way of example, linear (e.g., up and down or side to side or front to back) motion of the base plate 105 is not sensed by the inner axis angular rate sensor, because it does not include rotational motion about the inner axis 130. Additionally, during normal use, as the inner axis 130 moves constantly relative to the base plate 105, motion sensed by the inner axis angular rate sensor is not motion of the base plate 105, nor is it motion of an object to which the base plate 105 is mounted.

35. Drive signals for the outer axis motor 230o are produced from a combination of angular rate detected about the outer axis 125 by the outer axis angular rate sensor 210o and signals from sensors in the upper sensor enclosure 150. Similarly, drive signals for the inner axis motor 230i are produced from a combination of angular rate detected about the inner axis 130 by the inner axis angular rate sensor 210i and signals from sensors in the upper sensor enclosure 150.

36. MakoHead does not include any sensors that determine (in two orthogonal axes or dimensions) motion of the moving object upon which MakoHead is attached. MakoHead does not include any sensors on its base plate 105 or any other location that sense motion of the moving object in two orthogonal axes or dimensions.

37. MakoHead does not include any sensor on its base plate 105, much less sensors that sense motion of the base plate 105 along two orthogonal axes. MakoHead includes only one single-axis sensor mounted in fixed relation to the MakoHead base plate 105, i.e., the outer axis angular rate sensor 210o. The outer axis angular rate sensor 210o is fixed to the outer axis motor 230o, which is fixed to yoke 110 that extends from the base plate 105.

38. MakoHead does not include any sensor package to sense motion of the base (i.e., base plate 105) or a moving object to which the base is attached, in two

orthogonal axes or dimensions. MakoHead does not require a determination of motion in two orthogonal axes or dimensions of the base plate 105, or motion in two orthogonal axes or dimensions of an object to which the base plate 105 is attached. Rather, MakoHead senses motion at the upper enclosure, and senses and controls motion (i.e., angular rates) about two separate axes, one axis in line with the output shaft of each stepper motor, where stepper drive signals cause the motors to produce stabilizing counter-rotations. It would be pointless for a MakoHead to sense motion of the moving object or the base in two orthogonal axes or dimensions.

39. MakoHead includes several sensors associated with the inner gimbal 140 and the upper sensor enclosure 150. These sensors ("inner gimbal sensors") are the inner angular rate sensor 210i and the sensors conceptually illustrated in the upper right quadrant of Figure 6. As the inner gimbal 140 and upper sensor enclosure 150 constantly move relative to the base (i.e., base plate 105) during normal use, the inner gimbal sensors do not determine motion of the base or motion of the object to which the base is mounted. Instead, they determine position and motion of the inner gimbal 140, to which the payload platform 155 is attached.

40. MakoHead includes only one sensor other than the inner gimbal sensors. That one sensor is the outer angular rate sensor 210o, which is a single-axis

sensor that senses rotational motion only about a single input axis. Motion of the base plate 105 that does not include rotation about the input axis of the outer angular rate sensor 210o is not sensed at all by the outer angular rate sensor 210o. If a motion vector for rotational motion of the base plate 105 includes a vector component for rotation about an axis that is parallel to the input axis of the outer angular rate sensor 210o, then the outer angular rate sensor 210o senses only that single vector component. The outer angular rate sensor 210o cannot sense any other vector component of the motion vector. From that single sensed vector component about a single axis, motion of the base plate 105 in two orthogonal axes or dimensions is not and cannot be determined. Even if, for the sake of argument, it was somehow possible to determine motion of the base in two orthogonal axes or dimensions from rotation sensed about the single input axis of the outer angular rate sensor 210o, MakoHead does not make such a determination. MakoHead simply does not sense motion of the base in two orthogonal axes or dimensions.

41. Every sensor in MakoHead, other than the outer axis angular rate sensor 210o, is mounted to a component that constantly moves relative to the base (i.e., base plate 105) during use and does not and cannot determine motion of the base (i.e., base plate 105) or motion of an object to which the base is

mounted. Instead, each such other sensor determines position and motion of the inner gimbal 140, to which the payload platform 155 is attached. MakoHead does not have any sensor, combination of sensors, or sensor package that determine(s), in two transverse directions, motion of the base or motion of a moving object on which the stabilized platform is mounted. MakoHead does not stabilize the payload platform in at least two dimensions based on information collected by a sensor package sensing motion of the moving object independent of motion of the payload platform. MakoHead does not continuously stabilize the payload platform in at least two dimensions based on information collected by a sensor package fixed relative to the moving vehicle and sensing motion of the moving vehicle.

42. The above statements are made with the knowledge that willful false statements and the like are punishable by fine and/or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that any such false statements may jeopardize the motion for summary judgment that this declaration supports.

Date: May 16, 2017 Thomas H. Smith

Only for document file Dec_FINAL.doc of May 16, 2017

By: /s/ Thomas H. Smith

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